

Adjunctive radiograph diagnostic in vertical mandibular asymmetry

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ABSTRACT

Background: The development of radio diagnostics in orthodontics is still a challenge in treating skeletal anomaly with facial asymmetry. The assessment of skeletal symmetry, which can be obtained by frontal radiographs such as panoramic radiograph and posteroanterior cephalograph, is still limited. **Purpose:** The aim of this study is to evaluate panoramic radiograph and posteroanterior cephalograph in measuring the vertical mandibular asymmetry based on Kjellberg technique. **Methods:** This study was a cross-sectional study of 43 pre-treatment panoramic radiographs and posteroanterior cephalographs from dental faculty students at Universitas Sumatera Utara between 18–25 years old. The subjects have fully erupted permanent teeth until the second molar and complained about facial asymmetry. The validity and reliability of vertical mandibular asymmetry of Kjellberg technique with Cliniview software in both radiographs used Cohen-K analysis. **Results:** The measurement of vertical mandibular asymmetry showed no significant differences using panoramic radiograph and posteroanterior cephalograph ($0.073-0.321 > 0.05$). **Conclusion:** The vertical mandibular asymmetry analysis with Kjellberg technique in panoramic radiograph is potent as an adjunctive diagnostic tool in vertical mandibular asymmetry.

Keywords: asymmetry; digital radiograph; mandibular; vertical

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INTRODUCTION

Establishing an improved level of reliability in mandibular asymmetry analysis has been a challenge in dentistry. Mandibular asymmetry is one of the common craniofacial abnormalities due to the lateral displacement of the mandible's midline, beginning with the growth of mandibular asymmetry or certain diseases that affect facial growth.^{1,2} Previous study explained that lateral deviations occur more frequently in the lower third of the face.³ Eighty-five per cent of the abnormalities show a tendency towards lateral displacement to the left side – which is inherited – so that excessive growth is seen on the right side, or less growth on the left side, of mandible.³ The skeletal deviation in facial asymmetry is equal to or greater than 2 mm.^{4,5} However, dimensional differences reported as equal to or greater than 4 mm are considered to be mandibular

asymmetry.^{6,7} According to Lin's study reporting the association between asymmetrical jaw function and joint remodelling in mandibular asymmetry patients, the 3-D morphology and bone density of the condyle on the deviated side differs from the non-deviated side.⁶ A previous study conducted on mixed dentition in patients between 8- to 12-years-old reported that more than half had moderate to severe mandibular asymmetry.⁵

Mandibular asymmetry can be diagnosed through clinical, photographic and radiographic examinations, which include frontal and lateral views, including lateral cephalograph, postero-anterior cephalograph (PA), panoramic radiography, cone-beamed computed tomography (CBCT), submentovertex and single-positron emission computed tomography (SPECT).^{8–10} In order to achieve a proper analysis, the measuring procedure is performed in order to obtain the qualified or quantified

value of the characteristics of a research subject. Mandibular asymmetry diagnosis is an important step in orthodontic treatment and a complicating factor in some malocclusion. Even though the PA cephalograph is ideal in the frontal assessment of the skeletal aspect of facial asymmetry, some limitations are associated with the use of cephalometric radiographs, such as standardization, reproducing head position and maintaining film–object distance. Since panoramic radiography allows the dental professional to view a large area of the maxilla and mandible on a single film, it is provided as an initial diagnostic image in dentistry.^{3,5,7}

Variable measurement produces a set of values or attributes from individuals called data. Data are analysed to provide information, which will be interpreted in the results. Errors in measurement, or measurement bias, can be anticipated or minimised with validity, reliability and generalisability in qualitative research. The concept of validity becomes an important matter when questioning the quality of the results of a qualitative study. The concept of reliability often becomes another consideration in assessing the scientific findings of qualitative research and also shows the consistency of findings when conducted by different studies.^{11,12} Thus, this study aims to measure the validity and reliability of panoramic radiograph and posteroanterior cephalograph in measuring the vertical mandibular asymmetry based on the Kjellberg technique.

MATERIALS AND METHODS

This study was approved by the Research Ethics Committee of the Universitas Sumatera Utara Medical Faculty and was conducted in Universitas Sumatera Utara Dental Hospital (Number: 114/TGL/KEPK FK USU-RSUP HAM/2018). This cross-sectional study commenced in September 2017, and continued until April 2018, and included 43 dental faculty students who complained about facial asymmetry, aged 18- to 25-years-old. The participants had fully complete teeth until the second molar and absence of caries and/or radix. They also had no orthodontic treatment or facial trauma history.

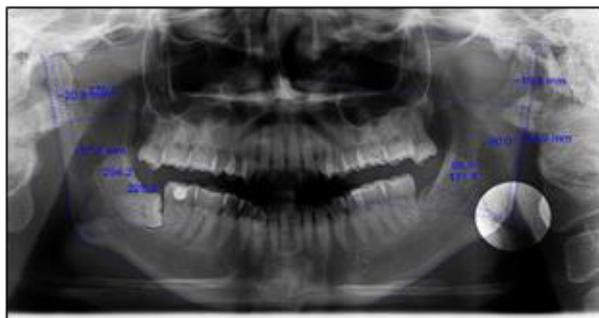


Figure 1. Condylar height asymmetry on panoramic radiography using *Cliniview* software.

The panoramic and PA digital cephalograph of all the volunteers was taken under standard conditions and processed in the same X-ray machine (OC200D1-4-1 with digital sensor by a single operator). The initial measurement of vertical mandibular asymmetry was performed by a single operator using *Cliniview* software (version 10.1.2) under a dentomaxillofacial radiograph specialist's supervision. Using this software, the parameter points to measure the condyle asymmetry index (IAK) are as follows: The condylar (CO) point is the most superior point of the condyle, whilst the mandibular notch (MN) is the lowest point between the coronoid process and the condyle process. The ramus line (RL) is drawn from the most lateral point in the condyle to the mandible angle. The gonion point (GO) is located on the tangent of the intersection of the ramus line (RL) and mandibular line (ML). CO, MN and GO points are reflected in the RL line, forming a 90-degree angle, as shown in Figure 1 and 2.

Evaluation was carried using the Kjellberg symmetry index (SI), of which more than 93.7 per cent is asymmetry (cit. Kjellberg).⁹ The initial measurement of inter-observer vertical mandibular asymmetry category on ten selected radiographs were analysed with Cohen's Kappa and showed fair agreement ($\kappa \geq 0.4$). The final measurement, begun four weeks after the initial measurement, was measured by the same operator using a specific schedule three samples per day.

$$\text{Kjellberg's symmetry index/condylar ratio} = \frac{\left(\frac{\text{CH}}{\text{RH}}\right)_{\text{small side score}}}{\left(\frac{\text{CH}}{\text{RH}}\right)_{\text{large side score}}} \times 100\%$$

Pearson correlation was performed to analyse the validity and reliability of condylar and ramus height in vertical mandibular asymmetry for both sides between panoramic radiograph and PA cephalograph. Since the data distribution was abnormal, a chi-squared test was used to obtain the difference between panoramic radiograph and PA cephalograph.

RESULTS

From 43 subjects of this study, the contribution of female subjects (62.8%) was higher than male subjects (37.2%),

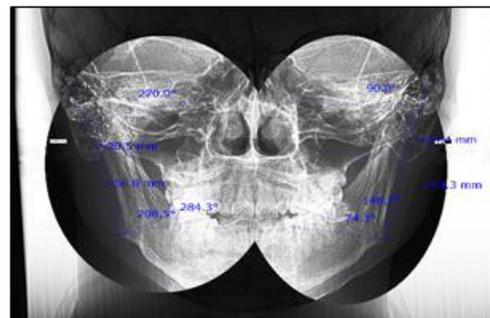


Figure 2. Condylar height asymmetry on Posteroanterior Cephalometry using *Cliniview* software.

Table 1. The results of the validity and reliability of mandibular asymmetry measurements in vertical direction on panoramic radiographs and postero-anterior cephalograph using Pearson test

| Measurements | r count value* | |
|-----------------------|----------------|-----------------|
| | Panoramic | PA Cephalograph |
| Right Condylar Height | 0.956 | 0.942 |
| Left Condylar Height | 0.938 | 0.925 |
| Right Ramus Height | 0.975 | 0.975 |
| Left Ramus Height | 0.978 | 0.978 |
| Index Symmetry (IS) | 0.949 | 0.945 |

Table 2. The results of condylar asymmetry between Panoramic radiography and Posteroanterior cephalograph using the chi-square test

| Measurements | Radiograph | Mean \pm SD | <i>p</i> -value * |
|-----------------------------|-----------------|------------------|-------------------|
| Right Condylar Height (CH1) | Panoramic | 19.08 \pm 3.23 | 0.073 |
| | PA cephalograph | 20.83 \pm 2.83 | |
| Left Condylar Height (CH2) | Panoramic | 18.79 \pm 3.24 | 0.299 |
| | PA cephalograph | 20.11 \pm 2.94 | |
| Right Ramus Height (RH1) | Panoramic | 57.70 \pm 5.74 | 0.266 |
| | PA cephalograph | 60.29 \pm 5.72 | |
| Left Ramus Height (RH2) | Panoramic | 57.08 \pm 5.75 | 0.287 |
| | PA cephalograph | 60.16 \pm 5.64 | |
| Index Symmetry (IS) | Panoramic | 89.67 \pm 3.12 | 0.321 |
| | PA cephalograph | 89.39 \pm 2.99 | |

and the mean age was 20.93 ± 2.21 years. Table 1 shows the results of the Pearson test in determining the validity and reliability of vertical mandibular asymmetry of 43 students using panoramic radiograph and PA cephalograph. The r-count value (0.938–0.978) was greater than r table (0.301, $n = 43$) and, based on the significance level of 0.05, was valid and reliable. The difference in measuring the vertical mandibular asymmetry with Kjellberg technique in panoramic radiograph and PA cephalograph with chi-squared (Table 2) showed no significant difference (0.073–0.321) > 0.05 . Therefore, the measurement of mandibular asymmetry in the vertical direction on panoramic radiography and PA cephalograph are valid and reliable.

DISCUSSION

As one of common craniofacial deformities, mandibular asymmetry is related to mandibular displacement and lateral shift in the mandibular midline. The asymmetric growth of the mandible or other certain diseases can affect facial growth. Some mandibular asymmetries are idiopathic, and non-syndromic asymmetry that develops gradually over the years after birth may become prominent during adolescence.^{3,6}

Panoramic radiography is widely used as initial diagnostic radiography because it demonstrates mandibular anatomy bilaterally by providing sufficient information for vertical measurements. PA cephalographs, as well as panoramic radiographs, provide valuable mediolateral information that is not only useful for facial asymmetric evaluation but also evaluates skeletal

craniofacial and dentoalveolar structures in the horizontal direction of view. However, the diagnostic accuracy and clinical efficacy of 3-D CBCT (Cone-Beam Computed Tomography) in the maxillofacial region is better than PA cephalographs.¹³

There are several methods and techniques in analysing vertical mandibular asymmetry, such as Habets and Kjellberg, based on panoramic radiograph. In this study, the Kjellberg technique is offered as acceptable clinical information in analysing condylar asymmetry within the limitations of these techniques in panoramic radiograph and PA cephalograph.^{9,14} Based on previous studies, the panoramic and PA cephalograph did not affect the condyle asymmetry index on both sides due to the accuracy and reproducible method in predicting asymmetry of mandibular anatomy with digital imaging, providing similar analysis in anatomical points of interest on the skull that are common in the two-dimensional radiographic images: correction of the magnification as well as possible tilt of the skull used the vertical marker, and adjusting the contrast and brightness of images.¹⁵

Previous studies also support the validity and reliability in the assessment of mandibular asymmetry in vertical directions using panoramic radiograph and PA cephalography, and they reported qualitative measurement in mandibular asymmetry differences for both sides.^{15–17} Van Eslande also identified the linear dimensions, especially in radiography, with some errors: distortion, magnification (either because of the projection geometry or because of the patient's position) and image accuracy in determining left–right differences or asymmetry. According to Kjellberg, the ratio is not affected by malposition, distortion or enlargement in the panoramic image.^{9,16}

The complexity of mandibular asymmetry is also related to the presence of temporomandibular disorder (TMD). In mandibular asymmetry subjects with TMD, there are no significant differences in unilateral and bilateral side of TMD patients when comparing the asymmetry between panoramic radiograph and PA cephalographs.¹⁸ However, there are significant differences of horizontal mandibular asymmetry based on menton deviation.¹⁰ The complexity of mandibular asymmetry can be simplified by early identification of the characteristic of mandibular asymmetry, whether vertical or horizontal, if there is no 3-D radiography. Based on this study, the early mandibular asymmetry can be detected by panoramic radiography with digital radiography improvement. The limitations of radiographic retrieval are restricted to radiation side effects, particularly in the treatment of malocclusions with developing mandibular asymmetry. In addition, PA analysis, which usually requires a special level of expertise, is not fully understood by general dental practitioners. Thus, the panoramic radiographs is widely used to observe the eruption and growth patterns of the teeth and jaw fracture, evaluate the maxillofacial and/or dentoalveolar complex and mandibular asymmetry, which may be associated with temporomandibular disorder (TMD).

The digital panoramic radiograph is potent as an adjunctive diagnostic tool in vertical mandibular asymmetry for early detection of complex mandibular asymmetry. Distortion in both radiographs can happen in linear measurements and magnification of some image areas in different regions because vertical measurements on radiograph panoramic are relatively more reliable if patient positioning is accurate and has good radiography quality. Due to some limitations associated with the use of PA radiographs, such as standardization, reproducing head position, maintaining film-object distance and requirement of special interpretation skill, the standardised radiography procedure and competence of digital panoramic radiograph analysis will help clinicians to obtain earlier asymmetry detection and minimise the radiographic exposure in analysing mandibular asymmetry development, treating skeletal anomaly with facial asymmetry, especially in the mandible.

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